MINERAL HOLDINGS AUSTRALIA PTY.LTD.
LIMESTONE, DOLOMITIC-LIMESTONE AND DOLOMITE RESOURCES

IN

NORTH – WEST TASMANIA

A Compendium of carbonate resources held directly or under agreement by Mineral Holdings Australia Pty. Limited.

Compiled by T W Dickson May 2008

Contents

MHA Exploration Titles SMITHTON TROUGH

RL9/97 Redpa 6Km²
Tertiary Limestone**,** Dolomitic limestone & Dolomite.

RL10/97 Togari 5Km²
Dolomite.

EL 15/2005 Montague 59Km²
Limestone, dolomite and dolomitic limestone.

MHA Exploration Titles ARTHUR LINEAMENT & ROCKY CAPE GROUP

RL1/2005 Thomas Mt. 5Km²
Quartzite and silica sands.

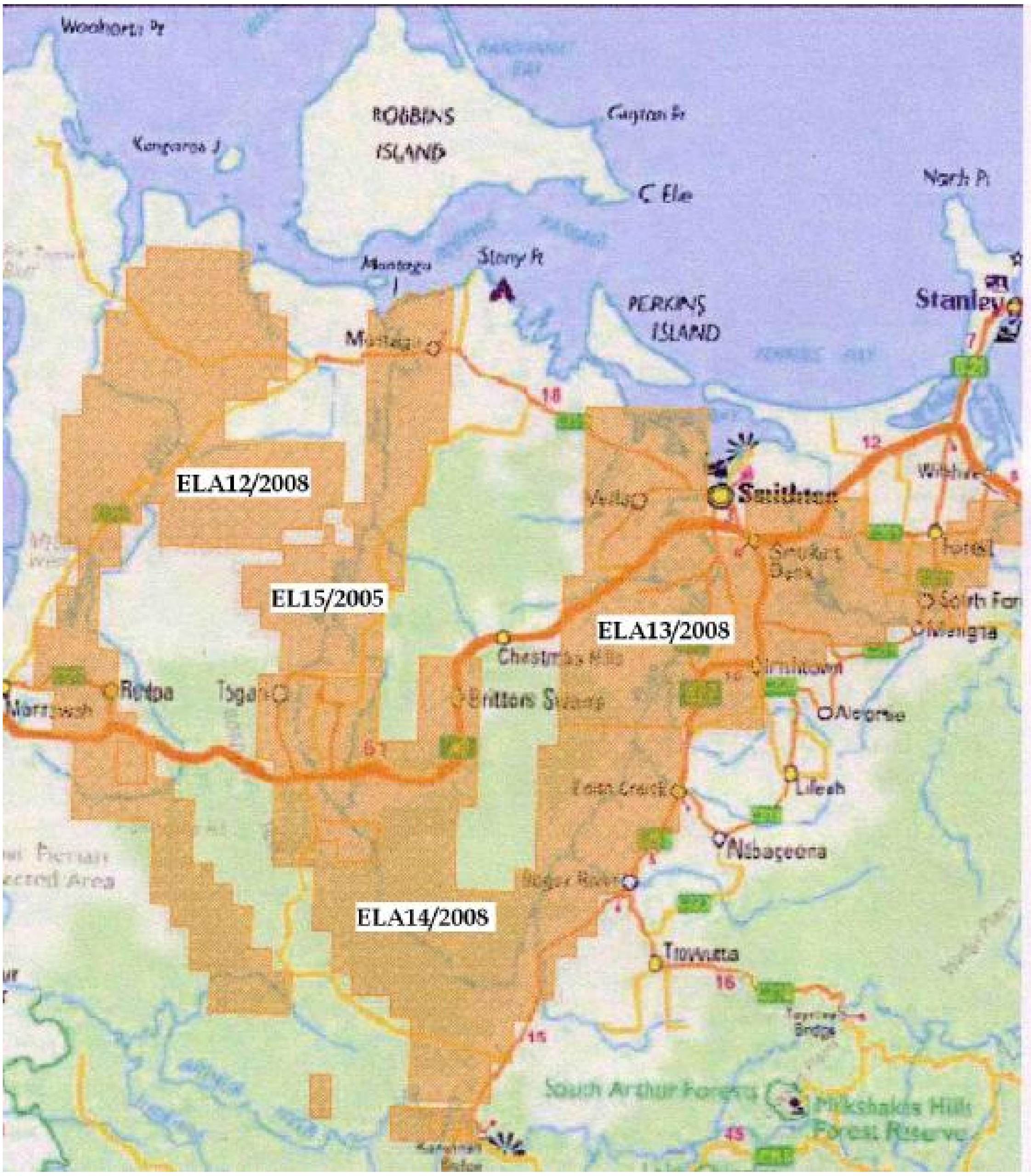
RL 1/2001 Meunna 2km²
Quartzite and silica sands.

RL 2/2006 Cann Creek 2km²
Magnesite and Talc.

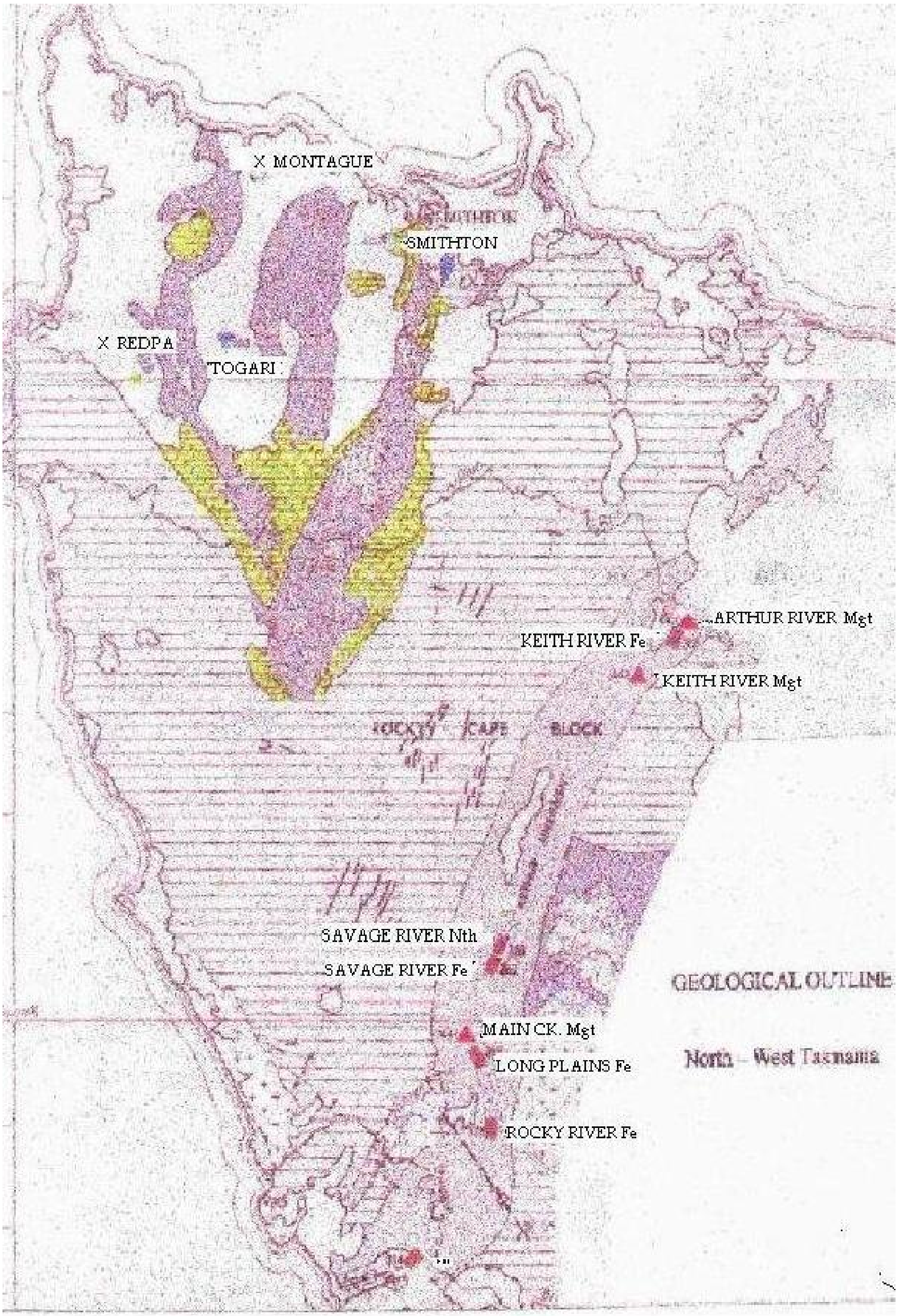
RL 2/1996 Champion road 2Km²
Silica flour.

RL 8718 Keith River 5Km²
Magnesite (Includes M1 Arthur River Area).

RL 8717 Lyons River 5Km²
Magnesite



Exploration Licence Applications 12/2008 235Km² Redpa, 13/2008 173Km² Pulbeena, and 14/2008 235 Km² Montague River cover all the carbonate outcrop and subcrop areas within the Smithton Trough.


X MONTAGUE
SMITHTON
X REDPA
TOGARI
ARTHUR RIVER Mgt
KEITH RIVER Fe
KEITH RIVER Mgt
SAVAGE RIVER Nth
SAVAGE RIVER Fe
MAIN CK. Mgt
LONG PLAINS Fe
ROCKY RIVER Fe
GEOLOGICAL OUTLINE
North - West Tasmania

Simplified Geological map of North West Tasmania

GEOLOGICAL SEQUENCE N-W TASMANIA

QUATERNARY		Recent cover, beach sands and gravels.
TERTIARY	**-** Merrawah Basalt	Olivine basalt
	- Redpa Limestone	Sub basaltic **LIMESTONE** and sands
Unconformity		
CAMBRIAN	**-** Dundas Group equivalents	Turbidites in Christmas Hills area
EO-CAMBRIAN	**-**Smithton Dolomite	Extensive banded to massive **DOLOMITE** with minor **DOLOMITIC LIMESTONE** and **LIMESTONE** at Montague.
	-Crimson Ck. Correlates	Turbidites and Basaltic lavas
	- Black River Dolomite	**DOLOMITE** with minor mudstone and chert
	- Forest Conglomerate	Orthoquartzite and conglomerate
Unconformity		
PRE-CAMBRIAN	**-** Irby Siltstone	
	-Detention Quartzite	**QUARTZITE & SILICA SAND**
	- Cowrie Siltstone	
	-Arthur Lineament	Sheared metamorphics with extensive **MAGNESITE BODIES & SAVAGE RIVER IRON FORMATION**

REDPA RL 9/1997 ($6Km^2$) Approximately 90Km from Port Latta.

Explored extensively for Tertiary Limestone
Pre-Cambrian Magnesian Limestones and
Pre-Cambrian Dolomites.

Evaluation work has included
-23 hand samples,
-26 hammer drill holes for 257 metres (mostly in limestone)
-7 shallow diamond drill holes (mostly testing dolomite)
-10 shallow hammer holes (to test the magnesian limestones)
- Several 250 tonne bulk samples for furnace testing.

The limestone was originally a wide spread sheet over a relatively flat lying Pre-Cambrian basement. It now occurs as a series of remnant hills around the edge of an extensive basalt sheet and most probably extending under the basalt cover.

The limestone is white to pink in colour and is generally dense and compact in texture. There are occasional cavities and the limestone can be sugary immediately adjacent to the cavity. Thickness from the drilling ranges from 1 to 18 metres and averages around 10 metres.

The limestone averages 54.02% CaO, 0.9% MgO, 0.66% SiO2, 0.17% TiO2, 0.28%Al2O3, 0.61%Fe2O3, 0.03% MnO2, less than 0.01% alkalies, 0.096% P2O5, 0.595SO3, and 45.11% LOI.

Some 5Mt of high quality limestone is available in the Redpa area and additional resources would be available along and under the basalt margin to the north and south.

Furnace tests on the limestone at 1150 to 1350° C indicated the material remained hard with no tendency to crumble or powder and that it would maintain integretyin a shaft kiln.

Magnesian limestone and dolomite occur as subcrop throughout the Redpa Retention Licence. The rock is hard and marbalised but is very fine grained dense and massive in appearance. It is usually light grey in colour but some of the magnesian limestones tend to be lighter in colour and this difference is believed to increase with depth. From the limited amount of shallow drilling it appears the magnesian limestones predominate at Redpa but the true distribution is not yet clear.

The structure in the basement rocks appears to be a broad shallow syncline and at least 1000metres of section is present. Any resource of dolomite or magnesian limestone is therefore very large.

The dolomite ranges from 31 to32% Cao and 18.8 to 19.5% MgO Silica is generally below 0.2% although occasional spikes to 10% do occur.

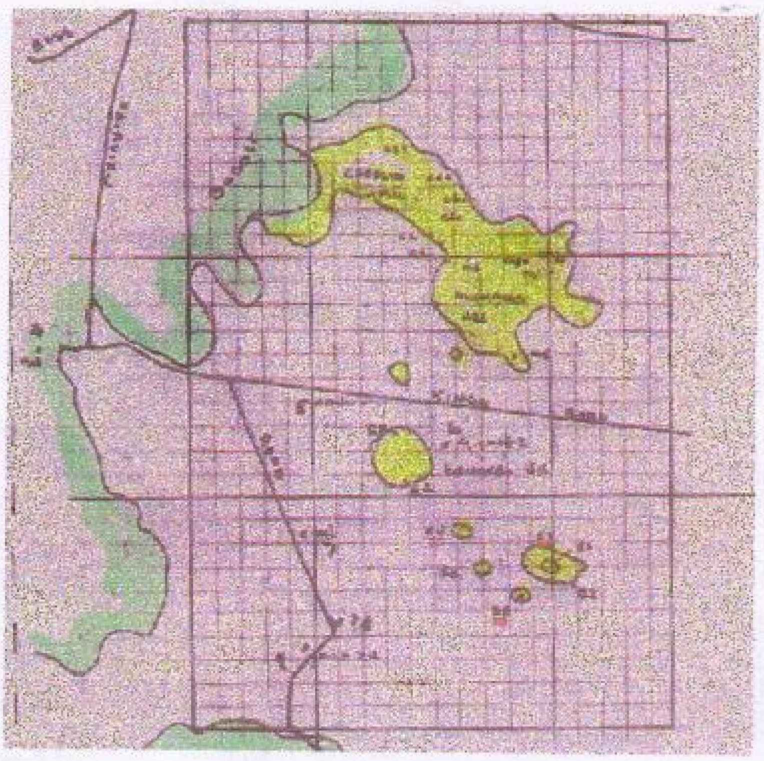
The Magnesian limestone contains 36-50% CaO, 5-16% MgO, 0.2 –1.4% SiO2, All other oxides are very low and LOI is 43.5-46.5%.

REDPA DOLOMITE, LIMESTONE AND DOLOMITIC-LIMESTONE ANALYSIS

(weight percentage)

(All numbers are average % composition)

	Limestone	Mag-rich Limestone (Dolomitic Limestone)	Dolomite
SiO_2	0.66	0.95	0.40
TiO_2	0.17	0.04	0.013
Al_2O_3	0.28	0.21	0.31
Fe_2O_3	0.61	0.09	0.23
MnO	0.03	0.01	0.006
MgO	0.90	13.95	21.40
CaO	54.02	38.31	30.41
Na_2O	<0.01	0.23	0.12
K_2O	<0.01	0.07	-
P_2O_5	0.096	0.037	-
SO_3	0.59	0.51	-
CuO	-	-	0.0005
Cr_2O_3	-	-	0.0009
L.O.I	45.11	45.33	46.97



Limestone Outcrops Redpa area.
(limestone – yellow, basalt – green, Basement dolomites and magnesian limestones uncoloured)

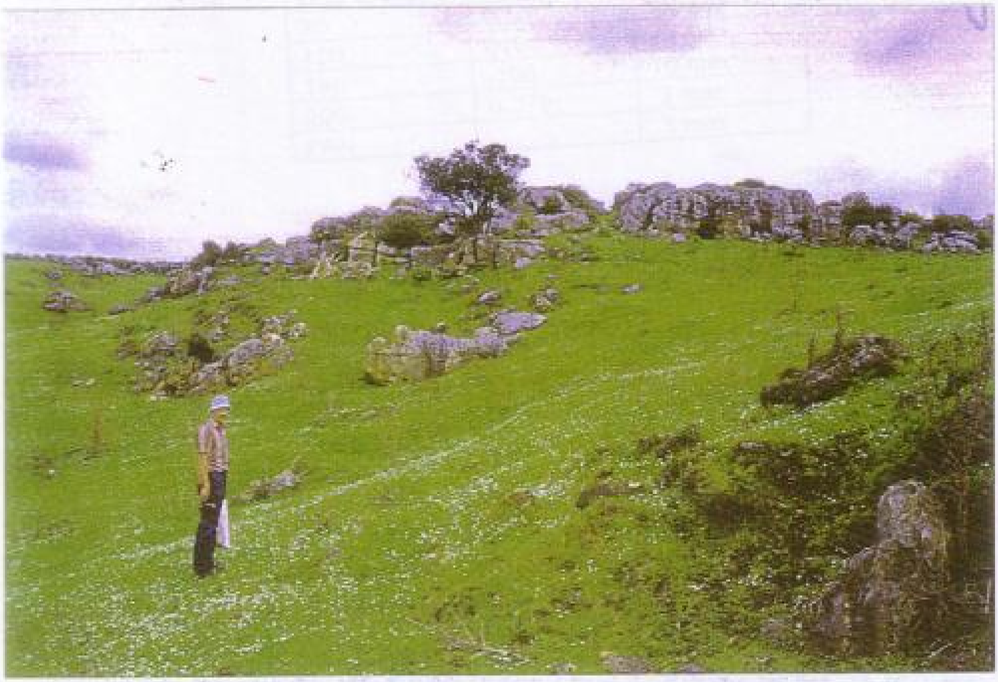
RETENTION LICENCE – RL 9/1997
HIGH GRADE PRE-CAMBRIAN
DOLOMITIC LIMESTONE – REDPA

SURFACE OUTCROPS AT CARBONATE HILLS

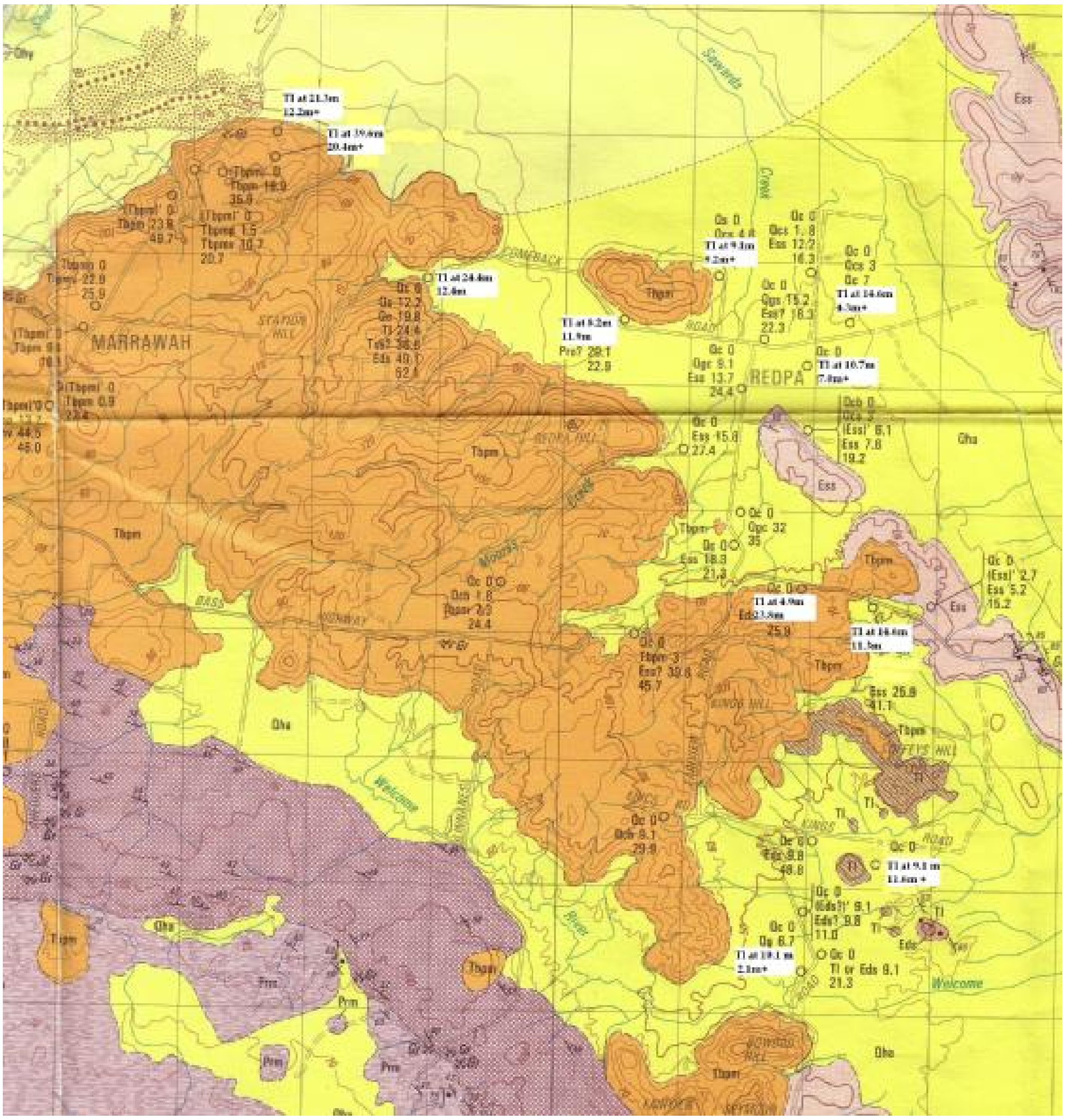
SURFACE OUTCROP AT CARBONATE HILLS

RETENTION LICENCE – RL 9/1997
HIGH GRADE TERTIARY
LIMESTONE – REDPA

SURFACE OUTCROPS AT CARBONATE HILLS



SURFACE OUTCROPS AT CARBONATE HILLS



Outcrop of Marrawah Basalt with boreholes intersecting Tertiary limestone

TOGARI RL 10/1997 ((Km²) Approximately 70 Km from Port Latta.

Explored solely for Pre- Cambrian Dolomite.

- 41 shallow backhoe pits were dug to provide depth of soil overburden and to provide samples of the dolomite.
- 5 hammer drill holes along existing track

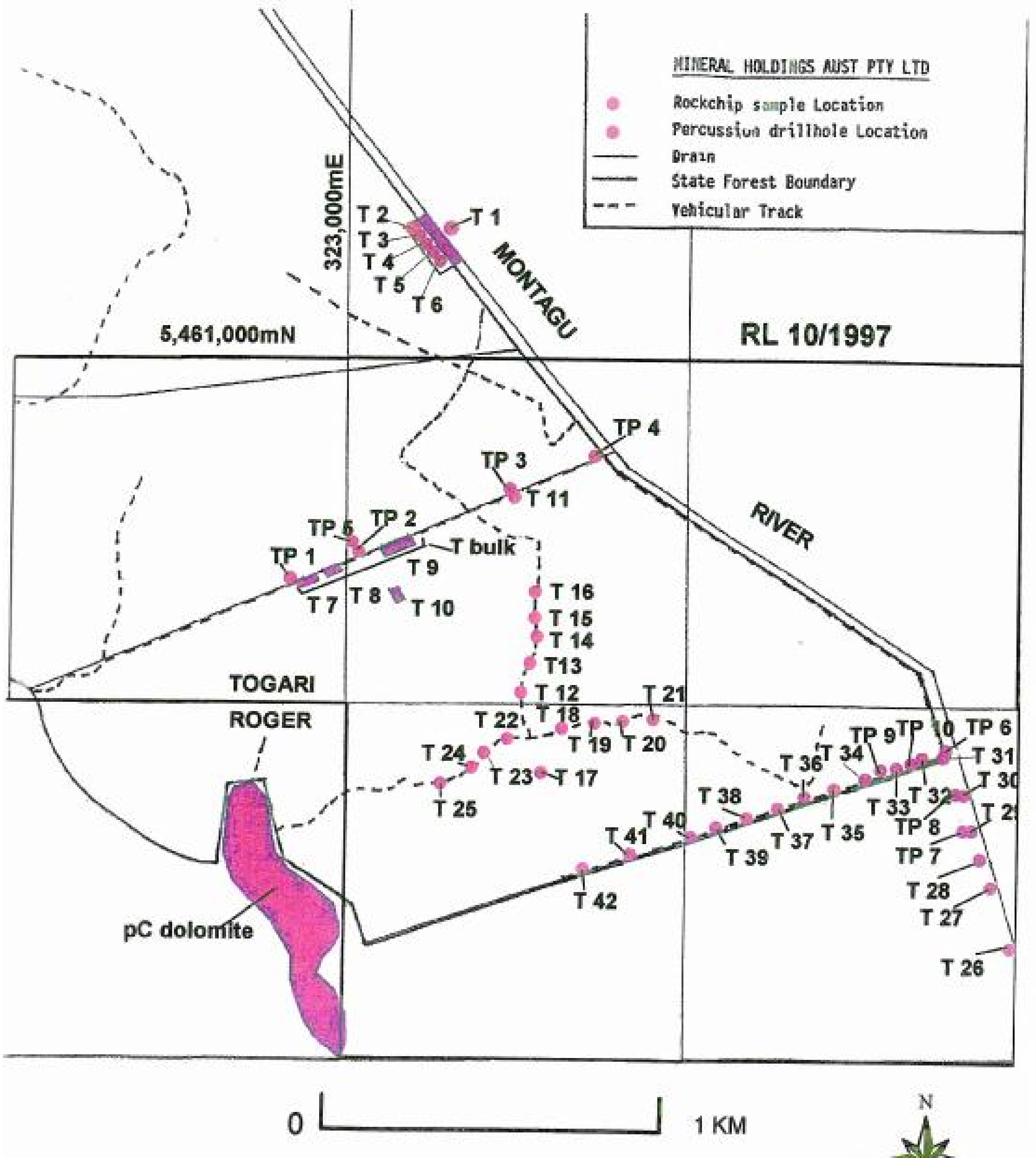
The Togari area lies on the steeply dipping east limb of a major anticline and with a stratigraphic thickness well in excess of 1000 metres very large reserves are certainly available. However the dolomite is generally low lying, covered by a thin soil layer, and is usually only exposed in drainage trenches. Where it can be seen the dolomite is greyish in colour, and is a hard massive fine grained marble. An average assay of the material is…

TOGARI DOLOMITE ANALYSIS
(weight percentage)
(All numbers are average % composition)

SiO_2	0.44
TiO_2	0.01
Al_2O_3	0.54
Fe_2O_3	0.24
MnO	0.005
MgO	19.62
CaO	32.86
Na_2O	0.08
K_2O	-
P_2O_5	--
SO_3	-
L.O.I	46.16

This compares more than favourably with average grades of existing suppliers…

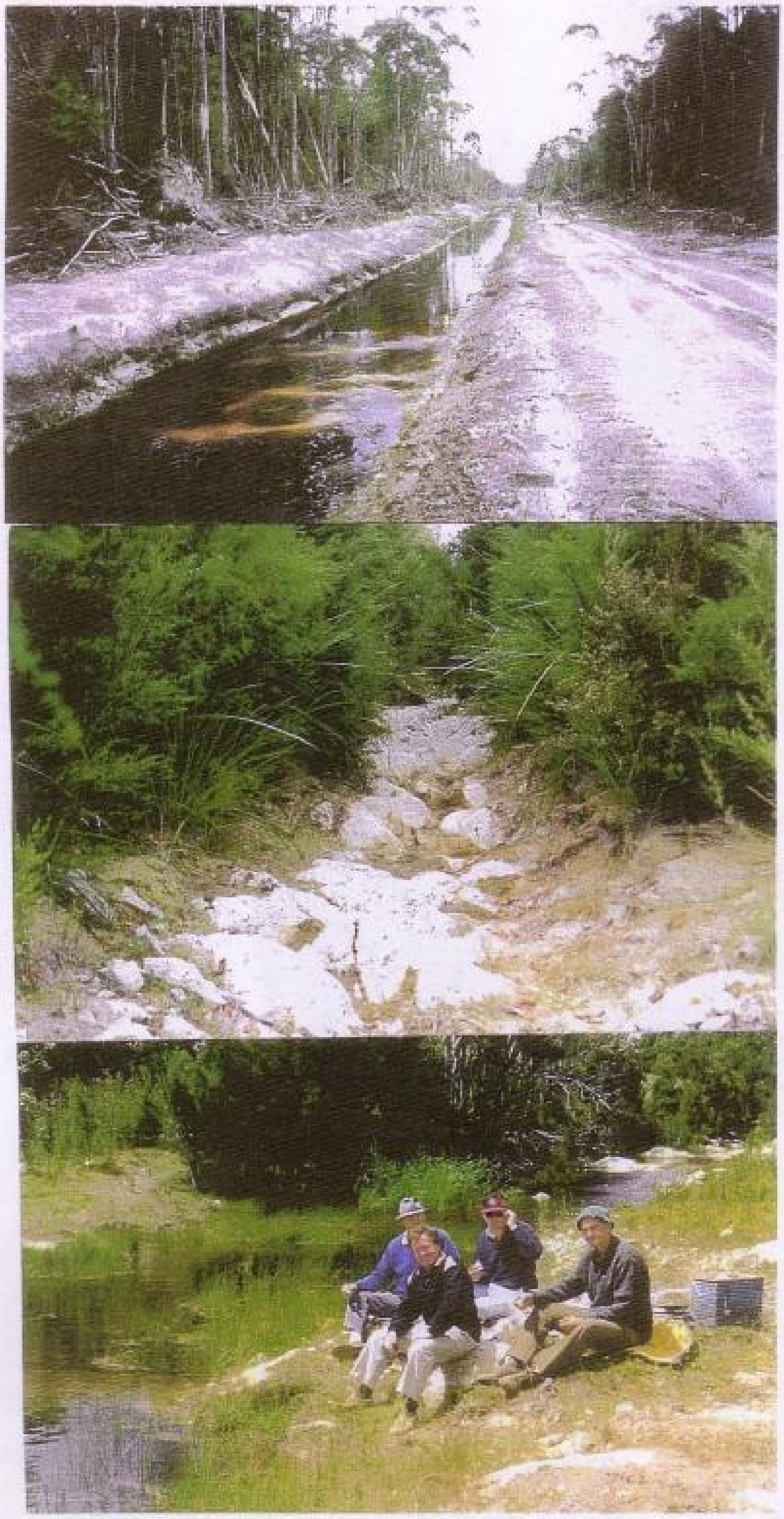
Supplier	Togari	BHP Ardrossan	ACI Mt Gambier
SiO2	0.44	2.00	1.0
TiO2	0.01	0.01	
Al2O3	0.54	0.39	0.5
Fe2O3	0.24	0.80	0.21
MnO	0.005	0.14	
MgO	19.62	21.00	18.8
CaO	32.86	29.00	33.7
Na2O	0.08		
K2O	-	0.048	
P205	-	0.05	
SO3	-	0.15	
LOI	46.1	46.40	



T 1-42 Dolomite rockchip sample, 1991, 1995
T bulk sample (500kg), 1995

TP 1-10 Percussion Holes, 1996/97

MHA DOLOMITE SAMPLING & DRILLING, BRITTONS SWAMP



TOGARI DOLOMITE.

GORDON L. BARNA
Vice President
Corporate Quality and Engineering

June 28, 1996

Mr. Neil M. Thomas, Chairman
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Melbourne, Vic., Australia 3000

Fax: 011-613-9650 3855

RE: TOGARI DOLOMITE

RETENTION LICENCE RL 10/1997

Dear Mr. Thomas:

Reference to the above subject covered in your letter of June 27th, I have reviewed all the XRF data provided. I further eliminated samples TPI 11-15M washed and unwashed as statistical outliers, and then averaged all the remaining data

The attached data sheet then compares washed to unwashed versus National's dolomite mined at our Natividad Plant in California. Note that the mineralogy calculations assume a stoichiometric CaO/MgO dolomite, whereas most dolomites can be enriched with either oxide. Thus, in this table I have shown the excess CaO as calcite which could mean this is calcite or enriched lime-dolomite.

The Togari dolomite shows very similar chemistry and mineralogy to National's. The difference between the washed v.s. unwashed is the reduction in quartz. For steel mill applications, washed v.s. unwashed would be unnoticed, since the silica ends up in the slag.

(Looks like you have a very high purity dolomite !)

Best Regards,

Gordon L. Barna

DOLOMITE - MINERALOGY NORMATIVE CALCULATIONS FROM CHEMISTRY 6/27/96

Oxide Mineral	MgO	CaO	Al2O3	SiO2	Fe2O3	LOI	Total	Sample TOGARI Washed
Dolomite	19.56	27.41				43.25	90.22	90.22
Calcite		5.09				4.00	9.09	9.09
MA Spinel								0.00
Pyrite					0.14	0.07	0.21	0.21
Anorthite		0.07	0.13	0.15			0.35	0.35
Quartz				0.13			0.13	0.13
Totals	19.56	32.57	0.13	0.28	0.18	47.32	100.02	100.00

Oxide Mineral	MgO	CaO	Al2O3	SiO2	Fe2O3	LOI	Total	Sample Togari unwashed
Dolomite	19.52	27.12				42.62	89.25	89.25
Calcite		5.46				4.27	9.73	9.71
MA Spinel								
Pyrite					0.17	0.09	0.26	0.26
Anorthite		0.08	0.14	0.16			0.38	0.38
Quartz				0.57			0.57	0.57
Totals	19.52	32.65	0.1[illegible]	0.73	0.17	46.98	100.19	100.17

Oxide Mineral	MgO	CaO	Al2O3	SiO2	Fe2O3	LOI	Total	Sample NRMC Natividad
Dolomite	20.91	29.06				45.67	95.64	95.65
Calcite		2.28				1.79	4.07	4.06
MA Spinel							0.00	
Pyrite					0.13	0.07	0.20	0.20
Anorthite		0.05	0.09	0.11			0.25	0.25
Quartz				0.49			0.49	0.49
Totals	20.91	31.39	0.09	0.60	0.13	47.53	100.64	100.65

TOGARI DOLOMITE (EL.33/90 TASMANIA)

28-Jun-96

Chemistry	Togari Washed	Togari Unwash	NRMC Natividad
CaO	32.57	32.65	31.39
MgO	19.56	19.52	20.91
SiO_2	0.28	0.73	0.60
Fe_2O_3	0.14	0.17	0.13
Al_2O_3	0.13	0.14	0.09
LOI	48.00	47.32	46.84
Total	100.68	100.53	99.96

Mineralogy

Dolomite	90.22	89.25	95.65
Calcite	9.09	9.71	4.06
Pyrite	0.21	0.26	0.20
Anorthite	0.35	0.38	0.25
Quartz	0.13	0.57	0.49
Total	100.00	100.17	100.65

MONTAGUE RIVER EL 15/2005 (59Km²)

Explored for Precambrian Limestone
Precambrian Dolomite

Evaluation work has involved
- Geological mapping
- 33 hand samples
- 12 hammer drill holes (testing for limestone) 2215metres
- Upgrading by crushing and screening.

The Dolomite outcrops poorly along the banks of the Montague River and in a restricted area 2km south west of Montague. The dolomite is a direct correlate of the Smithton Dolomite. It is about 1200metres in stratigraphic thickness and dips to the east along the west limb of the Smithton "Trough" or syncline.

The rock is a hard fine grained marble. It is dense and massive to crudely banded in appearance and is generally white to light grey in colour.

The average of fifteen chip samples, taken over widths of 5 to 20 metres, is 33.1% CaO, 18.9% MgO, with 0.3% silica, 0.12% Fe2O3, 0.5% Al2O3, 0.2% P2O5, 0.03% Alkalies, 0.01% MnO, and 0.05% TiO2. LOI is 46.4%.

The dolomite is high grade and is identical to the Togari dolomite which occurs some 15 to 20 Km to the south along the same stratigraphic horizon. It would no doubt behave similarly in furnace trials.

The Precambrian Limestone was first detected in one very high grade sample in an area of supposed dolomite outcrop 2 Km south west of Montague. The rock was much darker than the typical dolomite. It was very fine grained and structureless but assayed 55.2% CaO, 0.66% MgO, with 0.11% Fe2O3 and Al2O3 and 0.87% SiO2.

Outcrop in the area is very poor but geological mapping indicated a number of small isolated outcrops of limestone from 1 to 3 square metres in extent. Follow up sampling of all the available surface outcrops confirmed the high grade low impurity nature of the limestone with CaO values in the order of 55%. The oupcrops form a zone about 50 metres in width and 500metres in strike length. The dip changes from almost vertical in the north to about 20 degrees to the east in the south. Dolomite outcrops that lie adjacent to the limited limestone exposures commonly show fine bedding and banding.

!2 shallow hammer holes (straight air blast with no reverse circulation) were developed as a first pass test of the limestone. The drilling system was a poor choice and results were inconclusive with either extensive contamination or the presence of shale and or dolomite bands which did not outcrop. Only 4 of the holes (D,E,F and G) intersected anything like the surface material with the rest containing 2 to 9 % MgO with 8 to 28 % silica and high iron and alumina values. It is impossible to reconcile the drill results with the surface sampling and clearly diamond core drilling or trenching is necessary to see exactly what is going on.

Further prospecting has located additional high grade limestone occurrences. Samples 25 (over 10 M) and 26 (over 20m immediately west of 25) returned CaO values of 55.2 and 52.7% in a zone close to the base of the Smithton Dolomite 4Km south of Montague. Sample 33 was taken over a 15 m zone 100 metres west of the drilled area and returned 51.1% CaO. There would appear to be at least two additional limestone horizons.

Amdel was requested to evaluate simple crushing and screening as a method of upgrading an already high grade sample. The primary crushing of sample 25 was used with a separation of +1.18mm and -1.18mm. The result was quite spectacular as slightly more than 20% of the Si, Ti, and Fe and slightly more than 40% of the Al2O3 reported in the -1.18mm fraction which made up less than 2% of the sample.

Table 1. Assays and Element Distributions for Montague River No. 25 Sample

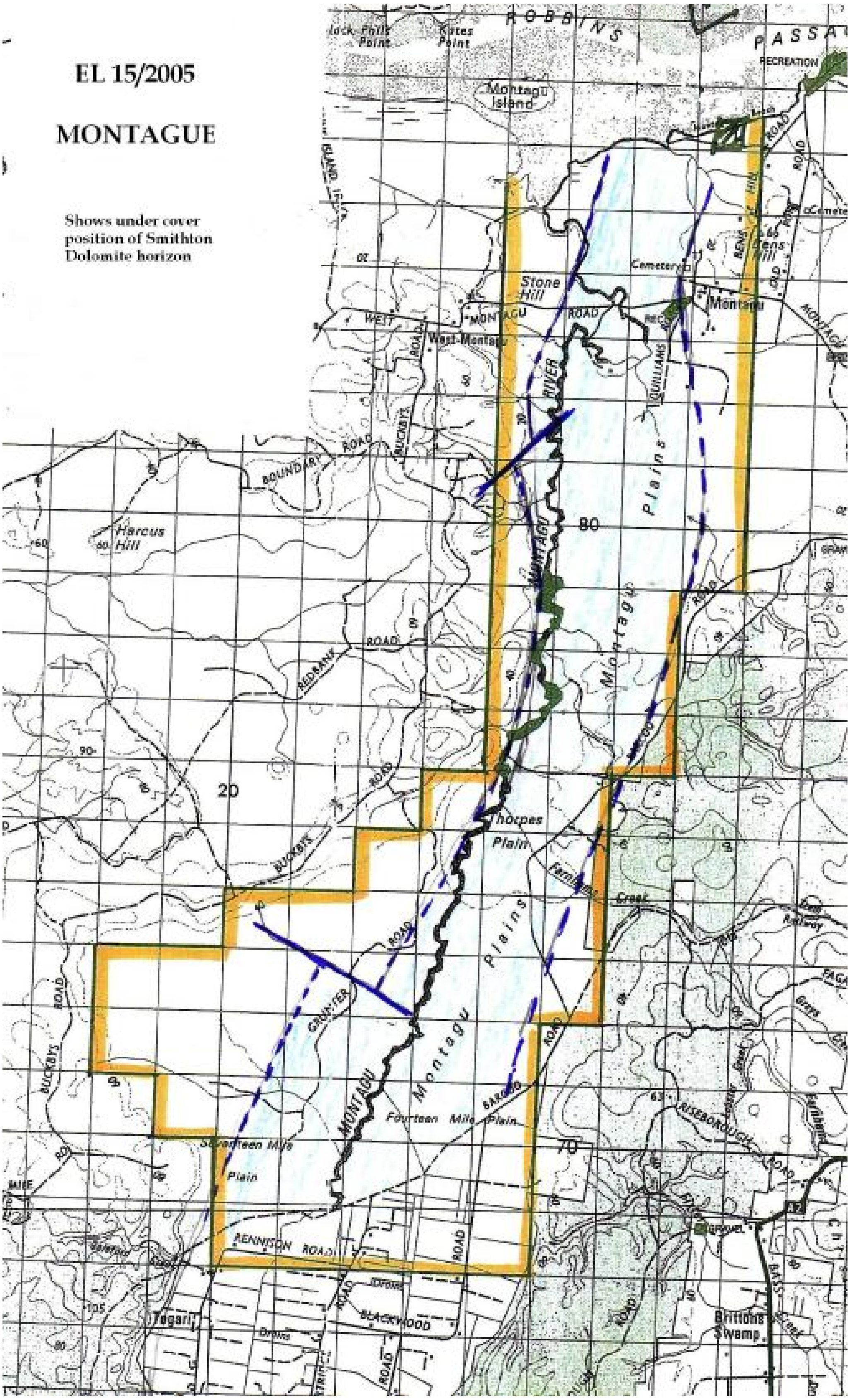
Element	Detection Limit	Assay (%)		Head Assay (%)		Distribution (%)		
		+1.18 mm	-1.18mm	Calculated	Actual**	+1.18 mm	-1.18mm	Total
SiO_2	0.01	0.18	2.6	0.23	0.14	78.4	21.6	100.0
TiO_2	0.005	0.003	0.035	0.003	<0.005	79.0	21.0	100.0
Al_2O_3	0.01	0.02	0.72	0.03	0.05	59.4	40.6	100.0
Fe_2O_3	0.01	0.05	0.88	0.07	0.07	74.9	25.1	100.0
FeO	0.1*	0.05	0.7	0.06	<0.1	79.0	21.0	100.0
CaO	0.01	55.0	52.0	54.94	55.2	98.2	1.8	100.0
MgO	0.01	1.4	1.19	1.40	1.1	98.4	1.6	100.0
MnO	0.01*	0.005	0.01	0.01	<0.01	96.3	3.7	100.0
K_2O	0.01*	0.005	0.27	0.01	0.01	49.3	50.7	100.0
Na_2O	0.01*	0.005	0.06	0.01	<0.01	81.4	18.6	100.0
P_2O_5	0.01	0.02	0.03	0.02	<0.01	97.2	2.8	100.0
LOI	0.01	43.2	42.4	43.19	43.8	98.2	1.8	100.0
H_2O	0.01	0.04	2.0	0.08	0.35	51.3	48.7	100.0
Total		100.0	102.9	100.0	100.7			

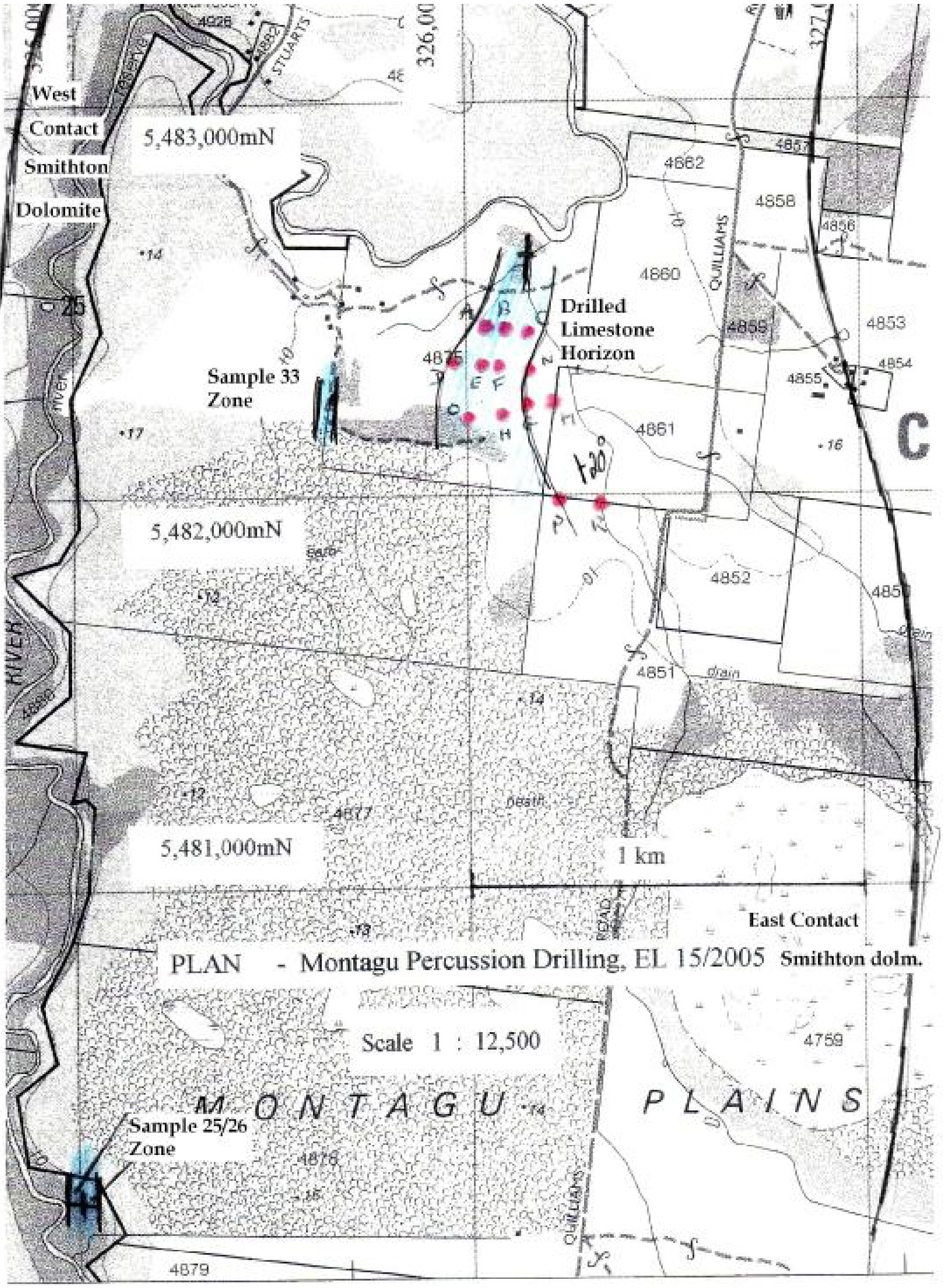
Sizing					
Wt. %			Wt. (g)		
+1.18 mm	-1.18mm	Total	+1.18 mm	-1.18mm	Total
98.13	1.87	100.00	517.91	9.85	527.76

EL 15/2005

MONTAGUE

Shows under cover position of Smithton Dolomite horizon





PLAN - Montagu Percussion Drilling, EL 15/2005

Scale 1 : 12,500

Typical limestone outcrops at Montague. Small isolated outcrops in flat with shallow soil cover.

Exploration Licence Applications 12/2008 235Km² Redpa, 13/2008 173Km² Pulbeena, and 14/2008 235 Km² Montague River.

These Licence applications cover all the carbonate outcrop and subcrop areas within the Smithton Trough and include The Smithton Dolomite and the stratigraphically lower Black River Dolomite. The aim is to actively explore the areas for additional high grade limestone lenses similar to the Montague Limestone in EL 15/2005.

LOOKING TO THE FUTURE

Limestone, dolomitic limestone, and dolomite are among the most widely used industrial materials. The raw material is used in everything from dimension stone, crushed aggregate, agricultural stone and a wide variety of fillers. In most cases it is the "look", the colour and the toughness of the stone rather than its chemical purity that is the most important feature.

On the other hand huge quantities of carbonate materials are calcined to lime, dolomitic lime, and magnesia for a wide variety of industrial uses. Important features of the calcination process are outlined by Andrew Graham of Mineral Strategies Pty. Ltd. in **Appendix 1**. In essence the application of heat breaks down the carbonate to a mineral oxide and CO2. Roughly half the weight of the raw material is driven off as CO2 so any impurities in the rock essentially double in the burnt product and purity of the raw material is much more critical in the production of calcined products.

Lime is an essential industrial chemical, with a formidable list of uses. It is used as a flux in steel making, in alkalies, soda ash and other chemical products, in glass making in agriculture and as a neutralizing agent in many chemical and metallurgical processes. Up until fairly recently high calcium lime was the major calcined product used but as Andrew Graham points out in a series of articles presented in **Appendix 2** the usage of dolomitic lime is increasing in some of the newer steel making processes and as a neutralizing agent and waste purifier because of its inherent higher reactivity. About the only usage which dolomitic lime cannot be substituted for high calcium lime is in cement manufacture where the magnesia content of Portland cement is critical at less than 5% and only relatively pure limestones can be used.

Andrew Graham also believes the advent of carbon trading will have a major effect on the composition and physical characteristics of the carbonates used to produce calcined products in the future. His arguments are outlined in **Appendix 3** and are basically;

- Less heat (or fuel) is required (and therefore less CO2 is produced) to calcine dolomite rather than limestone.
- The calcined dolomite is a better and more reactive product which is also cheaper to produce.
- CO2 released in the decomposition of the carbonate can be trapped and sequestered from a vertical kiln whereas it cannot be trapped from a horizontal kiln.

- A vertical kiln uses less heat (fuel) and has a lesser retention time (and therefore produces much less CO2, from fuel burning, during the heating process) than does a horizontal kiln.
- The less efficient horizontal kilns are the main suppliers of lime at present simply because coarsely crystalline and shell type carbonates are the most easily accessible source of carbonate. Coarsely crystalline limestones, marbles and shell carbonates break up and powderise (or decrepitate) during calcination. They don't burn correctly, tend to clump together, and severely disrupt the air flow in the heating chamber. These types of carbonates require a much longer retention time in the furnace and can only be successfully burnt in a vertical kiln.
- The coarsely crystalline limestones, marbles and shell carbonates remain cheap source of lime while CO2 is not taken into account but will become costly with carbon trading due to the extra heating time and especially if the released CO2 cannot be trapped.
- Only very fine grained or cryptocrystalline carbonates can be used in vertical kilns as the heat is uniformly transferred through the rock more efficiently and this type of material is ideal to take advantage of the shorter heating time and potential to trap released CO2 in the vertical kiln.
- Graham suggests that as carbon credits are introduced the ecomonics will change drastically so that vertical kilns which are more heat efficient and allow trapping of the released CO2 will become the norm.
- If that is the case then cryptocrystalline carbonates like MHA's limestone, dolomite and dolomitic limestones will be required in preference to normal crystalline limestones which will cost much more both in heat and CO2 credits to process.
- Dolomites as a source material will also be preferred as they produce a more reactive product with less heat input.
- MHA's carbonates contain very little in the way of impurities which will use less waste heat in processing and a better product.
- **MHA's cryptocrystalline carbonates will become a premium product.** The use of vertical kilns will provide major processing cost savings (less fuel and less CO2 produced in the burning of that fuel) through lower cost of heating, less retention time in the kiln as well as the ability to trap the released CO2 from the calcination process.

In Appendix 3 Andrew Graham has assessed the potential of the major sources of carbonate around the Pacific Rim and ranked them as to their suitability for kiln performance and energy usage. The tables are reproduced here and MHA's carbonates at Redpa, Togari and Arthur River rank very highly. Background data for the ranking is provided in Appendix 3.

Table 2: A comparison of various carbonates within Australia and the world and their calcining characteristics.

Typical Analysis	Caroline Limestone (SA)	Penrice Marble (SA)	Gambier Limestone (SA)	Heywood Limestone (VIC)	Lilydale Limestone (VIC)	Buchan Limestone (VIC)	Lara Limestone (VIC)	Ardrossan Dolomite (SA)	Redpa Limestone (TAS)
Calcium (Ca)	39.30	38.50	38.00	37.00	32.80	39.00	30.13	21.53	38.59
As Calcium Oxide (CaO)	55.02	53.90	53.20	51.80	45.92	54.60	42.18	30.14	54.02
As Calcium Carbonate ($CaCO_3$)	**98.25**	**96.25**	**95.00**	**92.50**	**82.00**	**97.50**	**75.33**	**53.83**	**96.46**
Magnesium (Mg)	0.44	0.35	1.00	1.00	8.30	0.30	3.60	12.35	0.54
As Magnesium Oxide (MgO)	0.73	0.59	1.67	1.67	10.00	0.50	6.00	20.58	0.90
As Magnesium Carbonate ($MgCO_3$)	**1.51**	**1.23**	**3.50**	**3.50**	**17.50**	**1.05**	**12.60**	**43.22**	**1.89**
Total carbonate content	**99.76**	**97.48**	**98.50**	**96.00**	**96.00**	**98.55**	**87.93**	**97.04**	**98.35**
Decrepitation Penalty	2.00	2.50	2.00	1.50	1.00	0.50	1.50	1.50	0.50
Grain Size Penalty	0.20	0.80	0.40	0.20	0.40	0.40	0.20	0.20	0.20
Hardness (UCS) Penalty	0.60	0.20	0.40	0.40	0.20	0.00	0.40	0.40	0.00
Revised available carbonate	**96.96**	**93.98**	**95.70**	**93.90**	**94.40**	**97.65**	**85.83**	**94.94**	**97.65**
Relative stone usage per '000 tonnes	1,023	1,055	1,036	1,056	1,051	1,016	1,156	1,045	1,016
Energy usage per '000 t (TeraJoules)	3,267	3,294	3,264	3,242	3,195	3,205	3,220	3,132	3,198
Ranking on kiln performance	**8**	**16**	**12**	**17**	**15**	**4**	**18**	**13**	**4**
Ranking on energy usage	**17**	**18**	**16**	**14**	**7**	**10**	**13**	**6**	**8**
Grain Size	Fine	Coarse	Fine - med	Fine	Fine - med	Fine - med	Fine	Fine	Fine
Hardness (compressive strength)	Low - med	Med - high	Medium	Medium	Med - high	High	Medium	Medium	High
Decrepitation potential	Med - high	High	Med - high	Medium	Low - med	Low	Medium	Medium	Low

Typical Analysis	Fujian Limestone (CHINA)	Vietnamese Limestone (VIETNAM)	Indian Dolomite (INDIA)	Egyptian Limestone (EGYPT)	Iranian Limestone (IRAN)	Dalian Magnesite (CHINA)	Arthur Magnesite (TAS)	Redpa Dolomite (TAS)	Togari Dolomite (TAS)
Calcium (Ca)	38.80	39.20	21.43	39.46	38.80	2.86	3.57	21.53	23.47
As Calcium Oxide (CaO)	54.32	54.88	30.00	55.24	54.32	4.00	5.00	30.14	32.86
As Calcium Carbonate ($CaCO_3$)	**97.00**	**98.00**	**53.57**	**98.64**	**97.00**	**7.14**	**8.93**	**53.82**	**58.68**
Magnesium (Mg)	0.10	0.03	12.00	0.07	0.30	25.80	25.92	12.84	11.77
As Magnesium Oxide (MgO)	0.17	0.05	20.00	0.12	0.50	43.00	43.20	21.40	19.62
As Magnesium Carbonate ($MgCO_3$)	**0.35**	**0.11**	**42.00**	**0.25**	**1.05**	**90.30**	**90.72**	**44.94**	**41.20**
Total carbonate content	**97.35**	**98.11**	**95.57**	**98.91**	**98.05**	**97.44**	**99.65**	**98.76**	**99.88**
Decrepitation Penalty	0.50	0.50	0.50	1.50	0.50	1.00	0.50	0.50	0.50
Grain Size Penalty	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.20
Hardness (UCS) Penalty	0.20	0.20	0.20	0.60	0.00	0.40	0.00	0.00	0.00
Revised available carbonate	**96.45**	**97.21**	**94.67**	**96.61**	**97.35**	**95.84**	**98.95**	**98.26**	**99.18**
Relative stone usage per '000 tonnes	1,028	1,020	1,048	1,027	1,019	1,035	1,002	1,009	1,000
Energy usage per '000 t (TeraJoules)	3,209	3,209	3,101	3,255	3,198	2,988	2,963	3,077	3,093
Ranking on kiln performance	**10**	**7**	**14**	**9**	**6**	**11**	**2**	**3**	**1**
Ranking on energy usage	**11**	**11**	**5**	**15**	**8**	**2**	**1**	**3**	**4**
Grain Size	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Very fine	Fine
Hardness (compressive strength)	Med - high	Med - high	Med - high	Low - med	High	Medium	High	High	High
Decrepitation potential	Low	Low	Low	Medium	Low	Low - med	Low	Low	Low

Appendix 1

Andrew Graham on

Considerations in relation to the calcinations of various carbonates.

Considerations in relation to the calcination of various carbonates

Introduction

World wide more than a 120 million tonnes of quicklime (lime) and dolomitic lime are produced every year. In addition, around 11 million tonnes of magnesite rock is mined every year for producing various magnesium based materials (i.e. Mg-oxide, Mg-hydroxide, Mg-chloride, Mg-sulphate and magnesium metal).

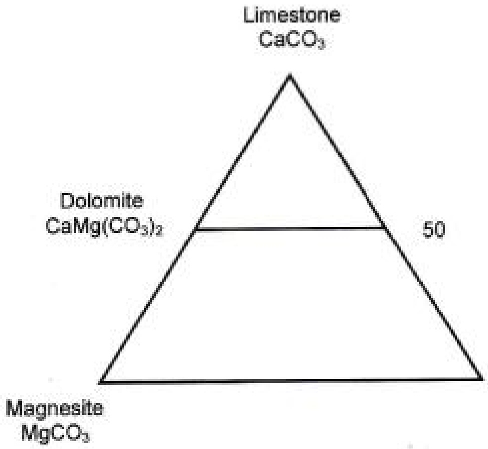
High purity limestone contains between 97 and 99% calcium carbonate ($CaCO_3$) whilst high quality dolomite contains approximately equal parts of calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$). High purity magnesite is similar to limestone in that it contains between 97 and 99% magnesium carbonate ($MgCO_3$).

From Figure 1 below it can be seen that limestone, magnesite and dolomite form part of a solid solution series where there is, theoretically, any combination from 100% calcium carbonate to 100% magnesium carbonate with a pure dolomite at the 50:50 position.

Between the dolomite and the limestone we have intermediaries known as dolomitic limestone and magnesian limestone, and, between the dolomite and the magnesite we have magnesian dolomite and dolomitic magnesite.

When comparing various carbonate materials we need to take into account the chemical differences and how these can affect the calcination process.

Figure 1: Phase diagram showing the solid solution series between limestone and magnesite.



Calcination Process

The calcination or burning of limestone, dolomite and magnesite is a simple chemical process. When heated the carbonates thermally decompose according to the following equations:

$CaCO_3$ + approx. 3,180 kJ (760 kcal) = $CaO + CO_2$

$CaMg(CO_3)_2$ + approx. 3,050 kJ (725 kcal) = $CaO.MgO + 2\ CO_2$

$MgCO_3$ + approx. 2,920 kJ (700 kcal) = $MgO + CO_2$

The decomposition temperature depends on the partial pressure of the carbon dioxide present in the process atmosphere. In a combustion gas atmosphere of normal pressure and 25% CO_2, the dissociation of limestone commences at 810 °C. In an atmosphere of 100% CO_2, the initial dissociation temperature would be 900 °C. Dolomite decomposes in two stages starting at approximately 550 °C for the $MgCO_3$ portion and approximately 810 °C for the calcium carbonate ($CaCO_3$). A high purity magnesite ($MgCO_3$) will begin to thermally decompose as low as 350 °C.

It requires approximately 1.8 tonnes of limestone, comprising 98% $CaCO_3$, to produce one (1) tonne of quicklime (CaO); approximately 2.0 tonnes of dolomite, comprising equal parts of $CaCO_3$ and $MgCO_3$ to make one (1) tonne of dolomitic lime (CaO.MgO) and 2.15 tonnes of magnesite, comprising 98% $MgCO_3$, to produce one (1) tonne of magnesia (MgO).

In order to fully calcine the stone (whether it is limestone, dolomite or magnesite) and to have no residual core, heat supplied to the stone surface must penetrate via conductive heat transfer to the core. A temperature of 900 °C has to be reached in the core at least for a short period of time since the atmosphere inside the material is pure CO_2. The stone surface must be heated to greater than 900 °C to maintain the required temperature gradient and overcome the insulating effect of the calcined material on the stone surface. When producing soft-burnt lime (including dolomitic lime) the surface temperature must not exceed 1,100 to 1,150 °C as otherwise recrystallisation of the CaO or CaO.MgO will occur and result in lower reactivity and thus reduced slaking properties of the burnt product.

A certain retention or residence time is required to transfer heat from the combustion gases to the surface of the stone and then from the surface to the core of the stone. Larger stones require longer time to calcinate than smaller ones – which also has implications from a production aspect depending on the strength of the stone and its tendency to break down into smaller size fractions (additional energy cost). In principal, calcining at higher temperatures reduces the retention time needed. However, too high temperatures will adversely affect the reactivity of the product. The relation between burning temperature and retention time required for different stone sizes is shown in the following table.

Stone Size [mm]	Calcining temperature [°C]	Approx. residence time [hours]
50	1,200	0.7
50	1,000	2.1
100	1,200	2.9
100	1,000	8.3

The grain size and the crystal habit of the stone is also very important in terms of the calcining dynamics. Heat transfer is more effective when the stone is fine grained or cryptocrystalline as compared to a coarse grained or macrocrystalline material. The boundaries between the individual grains are also important as these markedly affect the heating dynamics in terms of heat transfer efficiency. These grain size characteristics are somewhat affected by the depositional environment but are particularly affected by any regional metamorphic events that may have occurred. Temperature and pressure (metamorphism) changes result in recrystallisation and under certain conditions will result in a major change in the grain size of the stone.

For example, the Penrice Marble Unit in South Australia was the result of a limestone that underwent high grade regional metamorphism (amphibolite facies) and became a coarse grained (saccharoidal) marble with both intra-granular (some of the grains were large enough that they lost internal strength) and inter-granular strength losses.

Depending on the exact nature of the metamorphic event the grain boundaries may become highly strengthened (sutured grain boundaries) or somewhat weakened (retrograde metamorphism). The heat transfer characteristics of the stone will be dictated to by these grain size characteristics.

When heating the stone there is a tendency for some stone types to break down along minute fracture systems or even for the grain itself to break (thermal shock) and become part of a granular mass that no longer contributes to the calcining process. In fact, if enough of this material is generated it can have a highly adverse affect on the total heating dynamics within a kiln. This tendency of carbonate materials to break down in a kiln environment is called decrepitation.

The decrepitation potential of a carbonate material is directly proportional to its grain size and both the intra-granular and inter-granular (boundary) strengths which can be quite well represented by the overall compressive strength of the stone. A material that has a tendency to decrepitate will have a significantly detrimental impact on the overall performance of the stone. A decrepitating stone will create heat shifts within the kiln (by interrupting the air flow dynamics) and as such some of the stone will become hard-burnt and some of the stone will be under-burnt. In both cases the reactivity of the final lime product is affected.

Conclusion
The ideal carbonate material is one that exhibits a fine or cryptocrystalline grain size and which has a high compressive strength. This material will have a tendency to remain intact throughout the heating process (little or no decrepitation) and will result in a superior end product due to more complete calcining in a lesser residence time.

When assessing any carbonate material and especially its impact in terms of CO_2 emissions these factors must be taken into consideration.

Appendix 2

Andrew Graham on

1. Re Carbonate Resources and Associated Issues September 17, 2007

2. An Overview of Dolomite and Dolomitic Quicklime as Fluxing agents in the Steel Industry (inc. Hismelt)

3. Re Cryptocrystalline dolomitic limestone resources in Tasmania.

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September 17, 2007

Re: Carbonate Resources and Associated Issues

Dear Neil

Following our discussions over the last few days I am pleased to send you my thoughts in relation to some of the major issues we discussed. Given the considerable demands on my time I am unable to be as comprehensive as I would like but most of the critical issues have been addressed to some extent.

Firstly, I believe that the carbonate resource(s) that you currently hold are world-class in terms of their chemical and physical make-up and do provide very real market-capture opportunities across the whole product scope (i.e. raw materials through to tertiary processing end-products).

Independent Study

As you are well aware I am in the latter stages of producing my own independent study into the carbonate markets and have, to date, identified markets in forty-eight (48) distinct industries over eight (8) major sectors for eight (8) carbonate or carbonate derived products. This study is well in excess of 400 pages and has identified and categorised over 1.5 million tonnes of annual product sales.

Industry Opportunities

As far as MHA's resource(s) are concerned your blessing could also be your curse without the right focus. Having all three major carbonates – magnesite, dolomite and limestone – present certainly provides a great many development options but this needs to be tempered with a strong conviction as to which market sectors will become the primary focus following development.

This will, of course, be determined by a great many factors not least of which is, what demands already exist and what demands will be created in the short to medium term.

For example, the HIsmelt plant (currently being constructed) in Kwinana, Western Australia not only represented (past tense as contract has already been awarded) an excellent market opportunity (will ultimately require 150,000 tonnes per annum of low silica, dolomite) but it flags the strong likelihood that the steel industry (in a global sense) will undergo some major shifts in the next few years.

The HIsmelt Process is essentially a Direct Ironmaking process that consists of a vertical, water cooled Smelt Reduction Vessel (SRV) that can be considered as a replacement for a traditional blast furnace. The SRV provides the opportunity to utilise low grade iron ores that would otherwise be unacceptable feed stock for a blast furnace as well as enabling environmentally sensitive sinter plants and coke ovens to be eliminated all together.

In addition, the Asian market place is growing rapidly in terms of the electric arc furnace industry and as such the SRV represents a means by which high quality, low cost iron metallic feedstock can be produced.

Why is this important?

It is important because the current and new generation SRV's will require high grade dolomite as a direct injection raw feed and it will target those dolomite resources that are able to provide a low silica material with appreciable magnesium units. As further explanation I have attached a brief article on the use of dolomite and dolomitic quicklime in the steel industry.

OneSteel's Ardrossan Dolomite

The HIsmelt operation in Kwinana will be sourcing its dolomite from the OneSteel dolomite operation near Ardrossan on S.A.'s Yorke Peninsula. The dolomite will be supplied as a minus 11mm rubble (i.e. not single sized) and will be shipped from the Ardrossan port facility in parcel sizes of around 20,000 tonnes. The initial contract period is likely to be two (2) years.

As discussed I have some mixed feelings in relation to this supply contract as I was responsible for developing the grade control model (1991) for the Ardrossan operation following almost five months of systematic grade control drilling and feel that there are some inconsistencies in the information that has come to hand.

Whilst the Ardrossan dolomite would generally be considered as a high grade resource, the development drilling did determine that there was considerable variation in the magnesium content and the presence of a well developed karstic topography meant that large sinkholes with free flowing sands and other associated contamination issues were common. In addition, it is my view that the high water flows that were experienced during the drilling campaign will hinder production in the future.

One additional independent study and one commissioned study that I undertook in February, 2003 focussed on liming agents (*) and dolomite fines (**) respectively and analyses received from the Ardrossan operation on their minus 11mm product were certainly much higher grade than I had experienced during my considerable involvement with that operation. This may reflect a greater tendency to "high-grade" the pit which would significantly affect the life of the resource (needs further investigation).

(*) *A Discussion on the Major Liming Agents in South Australia and the Associated Commercial Opportunities, February, 2003.* (8 major products were analysed and discussed).

(**) *Domestic and Export Sales Opportunities for Dolomite Fines from CSR Readymix (S.A.) Operations at Riverview and Montacute Quarries, February, 2003.*

Quicklime Industry

As discussed the quicklime industry offers a lot of scope for those who are able to see the true opportunities. All the major players would have us believe that the market is well and truly locked away and in some cases over-supplied. This is not a true reflection of what is occurring as my current investigations are indicating.

Let's consider the Western Australian market place. There are four major lime producers in Western Australia who provide approximately 900,000 tonnes to the market place. The largest of these operations (and one of the largest quicklime plants in the world) is owned by Cockburn Cement and is located at Munster approximately 30 kilometres south of Perth. This plant currently produces in the region of 400,000 tonnes of quicklime annually from lime shells dredged from Cockburn Sound.

It should be noted that not only is the dredging an environmentally sensitive issue that has received considerable opposition but the quicklime plant is unable to operate using any other raw material source (i.e. purpose built).

Virtually all of the current quicklime production in Western Australia is of a low grade form with calcium oxide values often around 70 per cent. Nevertheless, quicklime users in W.A. are considered to be paying (typically) 10 – 20% more for their lime (on an equivalent CaO basis) than in other developed countries. Current prices are around AUD$100 – AUD$120 per tonne implying that the W.A. market is worth in the vicinity of AUD$100 million per annum.

Current production capacity is thought to be around 1.2 million tonnes per annum.

The Exmouth Limestone deposit has been touted as the saviour in terms of providing a raw material for high grade quicklime manufacture but it has never gotten off the ground for a number of operational and managerial issues that I will not go into at this stage.

In terms of end users the alumina industry (via Alcoa) is the largest quicklime consumer with approximately 500,000 tonnes being consumed annually. Alcoa primarily use the quicklime as a "cheap" means by which they can recover caustic (sodium hydroxide) from their process stream for re-use in the plant. The Alcoa operations in W.A. are some of the largest alumina operations in the world and as such are flagships for the Alcoa Corporation. However, environmental issues have been more prevalent in recent years and have placed further pressures on the W.A. government in terms of approving the latest upgrade plans at the Pinjarra operation.

The Pinjarra operation wants to expand by another 400,000 tonnes per annum which could potentially see another 50,000 tonnes of quicklime enter the market place.

What is the importance here?

The environmental issues surrounding the alumina industry include the efficiency at which the caustic can be recovered. This in turn is a direct reflection on the ability of the quicklime to facilitate the recovery process. The lower grade the quicklime the less efficient the recovery (this also has a major cost implication as caustic is a very expensive reagent).

This offers a major opportunity to the right group. The W.A. quicklime market could be significantly affected by the introduction of a very high grade quicklime (which requires a high grade limestone) as Alcoa would be willing to make the switch in order to improve their caustic recoveries and address some of their environmental issues.

The reason it hasn't occurred to date is simply because of Cockburn Cement. They have a 400,000 tonne quicklime plant which cannot operate on any other raw material than the lime shells dredged from Cockburn Sound. They have a vested interest in maintaining the industry exactly where it is despite the fact that the quicklime consumers have to be content with a low grade product.

This statement is borne out by the fact that Cockburn Cement have a near new Maerz twin shaft regenerative lime kiln of approximately 80,000 – 100,000 tpa capacity sitting idle at their Kwinana operation.

The question is not so much as to whether the market should be shaken up but whether the quicklime is best produced locally or closer to the desired raw material source (e.g. Port Latta). There are obviously a range of logistic and commercial issues attached to this decision.

A new player in the market place would be aided by the current inflated prices and the very real distinction that they would be the only high grade quicklime provider in the state.

Magnesia Opportunities
There has been a lot of talk in recent years regarding magnesium metal manufacture and at one stage there were 8 new magnesium metal plants being proposed for development in Australia (the world market could sustain 2 – 3 plants in Australia). However, given the extremely poor performance of the AMC project in Queensland the entire industry has received a lot of bad press and has been somewhat tarnished in the eyes of potential investors.

This has made discussions around magnesia related issues somewhat more difficult as people often do not make the distinction between the various end products.

I have very little interest in the magnesium metal industry but I have considerable interest in the various magnesia products including magnesium bicarbonate and magnesium hydroxide and in fact Mineral Strategies is a leading organisation in the development of specialist magnesium based cements and binders.

The capital required to launch a magnesium metal operation is generally between AUD$850 and $1,200 million depending on the size and configuration. However, for a fraction of that cost a calcining operation (and possibly additional on-processing streams) could be established to produce various magnesia grades whilst still realising a reasonably significant proportion of the sale price attributable to magnesium metal.

In other words, why risk the producing Mg metal when the economics (not to mention the much lower risk) of producing the precursor materials are far more attractive.

In this regard, MHA hold a significantly attractive resource in terms of raw material quality as well as access to natural gas and a deep port facility which are major considerations for establishing a calcining facility and tapping into the significant export market opportunities (have identified numerous opportunities via my independent market study / analysis).

Conclusions
The carbonate market is alive and well and there are numerous opportunities in both the domestic and international market place. However, a focussed approach is necessary and as such I would advocate that 3 or 4 primary markets be singled out for attention and fully developed through to an investor-ready status.

AM Graham

Andrew Graham
BAppSc MEconGeol QMCert MAusIMM MIQ

Attachment: Overview of dolomite and dolomitic lime in the steel industry.

An Overview of Dolomite and Dolomitic Quicklime as Fluxing Agents in the Steel Industry (Inc. HIsmelt) and the Implications for the MSP Group

In order to provide adequate protection to the refractories used in the steel industry there are two (2) critical factors that must be controlled:

1. Slag Basicity – which is the ratio of the quicklime (CaO) component to the combined silica (SiO_2) and alumina (Al_2O_3) components, and is generally expressed as B_3 = %CaO / (%SiO_2 + % Al_2O_3), and

2. The maintenance of a slag saturated with magnesium (8 – 15%).

In many steel plants around the world these two (2) factors are attended to through the addition of quicklime (CaO) and magnesite ($MgCO_3$) to the reaction vessel. These raw materials are referred to as fluxing agents.

Numerous studies have been conducted, worldwide, in relation to fluxing agents in the steel industry with the manner and rate of dissolution of the fluxes emerging as primary considerations. Fortunately, the rate of dissolution of magnesite and dolomite are essentially the same for similar conditions indicating that substitution is possible.

Studies conducted in the United States have shown that as long as the basicity is below about two, dolomite should readily replace magnesite in the fluxing process whilst also contributing important calcium oxide (CaO) units.

As far as the HIsmelt (Kwinana, W.A.) slag is concerned it has the following properties:

Calcium Oxide(CaO)	36.8 %
Silica (SiO_2)	29.4 %
Alumina (Al_2O_3)	17.4 %

This gives a basicity (B_3) = 36.8 / (29.4 + 17.4) = 0.79 which is less than the critical value of 2 for which dolomite can readily substitute for magnesite.

Further to this, studies have also shown that dolomitic quicklime (calcined dolomite) is also well able to substitute for magnesite as well as providing direct CaO units to the fluxing process (i.e. partial substitution for quicklime). Not only is this technically feasible but the cost down benefits are often substantial according to the numbers stated in various studies. In fact, some researchers claim that the cost benefit from using dolomitic quicklime as a fluxing agent may be as high as 20 per cent.

As far as the MSP Group (Kulpara Mine) is concerned these study findings strongly support further investigation into the calcination potential of the [illegible] Mine dolomite and its ability to yield a high grade dolomitic quicklime for the steel industry.

In relation to the HIsmelt process at Kwinana (W.A.) the dolomite from the OneSteel Operation at Ardrossan (S.A.) was chosen as the preferred fluxing material. However, should the MSP Group be able to value-add its dolomite through the manufacture of dolomitic quicklime, a strong case can be put forward, based on the research conducted overseas, to justify the change to dolomitic quicklime.

If appreciable tonnes of dolomitic quicklime can be produced then the Group would have the opportunity to market the product to other steel plants / producers as a superior fluxing agent. This factor is of significant importance given the fact that the quicklime currently available in Western Australia is generally of a low grade and is considered by users to be about 10 - 20% more expensive than in other developed countries.

The calcination trials currently being conducted on the Kulpara dolomite by Maerz Ofenbau in Switzerland will enable a definitive cost-benefit analysis to be undertaken. Should this analysis yield satisfactory results it will further undergird the current market research and development study and enable the Group to make a concerted marketing thrust into a the steel industry as well as other strategic industry sectors.

Prepared by Mineral Strategies
July, 2003

December 1, 2007

Attention: Neil Thomas
Mineral Holdings Australia Pty Limited
11 Kent Court
Toorak, VIC, 3142

Dear Neil

Re: Cryptocrystalline dolomitic limestone resource in Tasmania

Following on from your correspondence with Mr. David Mendelawitz of the Fortescue Metals Group regarding the cryptocrystalline carbonate resources in Tasmania I am pleased to offer some additional insights which I believe will contribute significantly to the discussions.

As you are aware Mineral Strategies Pty Ltd has completed a number of extensive in-house reports pertaining to carbonates (i.e. limestone, dolomite and magnesite) and their associated manufactured end-products (i.e. quicklime, dolomitic lime, magnesia, precipitated calcium carbonate, basic magnesium carbonate etc.) with a specific focus on the domestic and near-international markets.

These investigations have shown that the domestic market for high grade carbonates from your Tasmanian deposits can be realistically set at one (1) million tonnes per annum and covers a wide variety of markets.

In addition, you may recall that we undertook two separate investigations into the establishment of a 100,000 tonne per annum dolomitic lime (CaO.MgO) plant and a 150,000 tonne per annum magnesia (MgO) plant in Tasmania based on MHA's high grade carbonates. Both of these projects returned IRR's (Internal Rate of Return) of 35% (at ten years) and excellent NPV's (Net Present Value) at discount rates of fifteen (15) per cent.

In terms of sales price this is very much dependent on the degree of processing (e.g. raw carbonate versus calcined products), the specific parameters of the end product and the markets into which the product(s) are being sold. In the civil construction market dolomite and dolomitic limestone (as rubble, scalps etc.) can sell for as low as $15.00 per tonne but once processed (i.e. calcined, hard burned etc.) can sell for hundreds and even up to thousands of dollars per tonne in specialised markets (pharmaceuticals, chemical additives etc.).

Obviously our previous investigations and associated reports are too extensive to outline in detail in this letter but we are certainly able to undertake a separate study if required.

In terms of energy differential you may also be aware that I have undertaken separate investigations into the performance of various carbonates in vertical shaft and rotary kiln environments. If we look specifically at dolomitic limestone (often used in the steel industry because of the magnesium units – helps to control slag basicity) the average heat consumption in a vertical parallel twin shaft regenerative kiln is 5,200 MJ/tonne whilst a standard rotary kiln is around 9,000 MJ/tonne. Electricity usage is small by comparison with approximately 35 kWhr/tonne required for dolomitic quicklime manufacture.

As far as China is concerned rotary kilns are the most common kiln type used for calcining carbonates. To this end, the energy usage (in terms of input) for most dolomitic quicklime (calcined dolomitic limestone) out of China is often 75% more than for the same sized vertical shaft kiln (parallel twin shaft regenerative).

Possibly of even greater concern, given the advent of carbon trading schemes, is the amount of off-gases that are generated by rotary kilns as compared to vertical parallel shaft kilns. For dolomitic limestone a vertical parallel shaft kiln will generate less than 1.5 kg NO_x / tonne whilst a rotary kiln will generate approximately 3.0 kg NO_x / tonne. In relation to carbon monoxide (CO) a vertical parallel shaft kiln will generate approximately 5.4 kg CO / tonne of dolomitic quicklime whilst a rotary kiln will generate approximately 26.7 kg CO / tonne of dolomitic quicklime.

In virtually every circumstance a vertical parallel shaft kiln will generate considerably less NO_x, CO, SO_2 and dust than a rotary kiln and with significantly less energy inputs.

Of course this does not take into account the difference in physical characteristics of the dolomitic limestone from place to place. Mineral Holdings Australia's Tasmanian dolomitic limestone is cryptocrystalline (very fine grained) and very well indurated (high compressive strength) with the grain boundaries being very well sutured (excellent thermal conductivity). Many of the dolomitic limestones in China, Malaysia, Japan (mainly low Mg levels) and India (poor infrastructure and quality control) are macrocrystalline (moderate to coarse grained), have lower compressive strengths and exhibit poor thermal conductivity.

The importance of this must not be overlooked as these characteristics have a major impact on the overall performance. A macrocrystalline dolomitic limestone with a poor to moderate compressive strength will have a tendency to break down in the heat zone (irrespective of the kiln type) – a phenomenon known as decrepitation. When decrepitation occurs the air flow within the kiln is adversely affected, the heat zone tends to shift or become distorted and under or over-burning also occurs. Macrocrystalline dolomitic limestone can generate 3 – 7% by weight of decrepitated material which has a major impact on energy usage as well as off-gas generation (more stone required for the same end result).

In terms of the physical and chemical characteristics of MHA's dolomitic limestone resource in Tasmania I am sure you will be able to furnish FMG with all of the necessary information. Suffice to say MHA's dolomitic limestone is possibly the most consistently graded and extensive resource of its kind that I have observed.

In relation to the tenements in Tasmania I am sure you will have that aspect well covered and from my previous discussions with the relevant government departments I see no reason why a calcining project in Tasmania could not be fast-tracked through the approval process. Incidentally, my direct discussions pertaining to gas and electricity supply have shown that there is ample capacity at very good market prices for such an undertaking.

As far as environmental restrictions are concerned you will be much better able to answer this question. From our previous discussions and the information obtained from the relevant authorities I am not aware of any specific environmental restrictions and believe that the only outstanding consideration may be the development of a Mining and Rehabilitation Plan (MARP).

I also concur with your assessment of the Port Latta facility which is able to accommodate Cape-sized vessels and currently has an excess capacity of approximately 8 million tonnes per annum. Depending on the shipping configuration it is possible that subsidies may be available from the Tasmanian Government to encourage additional industries to the region.

MHA's Tasmanian carbonates (limestone, dolomitic limestone dolomite and magnesite) are world class in terms of their areal extent, chemical purity, chemical consistency and physical characteristics (grains size, compressive strength, thermal conductivity) and represent an excellent opportunity for development given the low sovereign risk, ready access to infrastructure and utilities, pro-development government and both domestic and international market trends.

If you require any further input please do not hesitate to contact me.

Many regards

Andrew Graham – Principal

Materials Technology - Business Development - Innovation - Resource Development
Strategic Planning - Waste Strategies - Environmental Systems
Commodities Brokerage - Project Management - Research and Development

Appendix 3.

Andrew Graham on

Raw Material Considerations in a Carbon Constrained Economy.

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Raw Material Considerations in a Carbon Constrained Economy

As we inevitably move towards a carbon constrained economy (see discussion below) it will become increasingly important for businesses to address the risks and opportunities presented by global warming and particularly the issues surrounding energy usage and Green House Gas (GHG) generation.

Businesses that are both high energy users and high GHG generators are going to be hardest hit and will have to be early adopters in environmentally friendly innovations in order to remain viable. This is particularly pertinent given the rapid rise of the carbon trading scheme which is likely to become a truly global phenomenon in the near future.

Kyoto Protocol

On 3 December 2007, Prime Minister Rudd signed the instrument of ratification of the Kyoto Protocol as the first official act of the new Australian Government. Subsequently, Australia has committed to meeting its Kyoto Protocol target, and has set a target to reduce greenhouse gas emissions by 60 per cent on 2000 levels by 2050.

Having entered into force three years ago, and with the first commitment period just started, the Protocol is now in full implementation mode. The Clean Development Mechanism (CDM) and the European Union Emissions Trading Scheme (EUETS) continue to be the major drivers in the international Kyoto market, but both are heading for a period of uncertainty.

The CDM has grown rapidly through 2007 with over 900 projects having been approved and these are expected to generate over 1 billion tonnes of CO_2 e (carbon dioxide equivalent) abatement. However, uncertainty about how the market for project credits will evolve beyond 2012 could start to afect project development and approvals.

As a party to the Kyoto Protocol, Australia now has an opportunity to participate more actively in the CDM. Austraia will move to establish a national registry and a Designated National Authority (DNA) to facilitate CDM activity. When a DNA is established Austraian companies will be able to look to this agency to support their involvement in CDM projects and will be able to hold Certified Emissions Reductions (CERs) in the Australian registry.

The Carbon Market

The global carbon market continues to grow rapidly with market turnover in 2007 of around 2.68 billion tonnes per year valued at around A$67 billion. This is up from around 1.6 billion tonnes and A$35 billion in 2006.traded volume is roughly divided 2:1 between trade in allocated "allowances" and trade in project-based credits although the balance is moving in favour of project credits, particularly CERs. The vast majority of this volume of trade is intended for compliance with the Kyoto Protocol.

Trading activity in the EU ETS is shifting from first pilot phase (2005 – 2007) trading to the main second phase (2008 – 2012). Phase 1 concluded with European Union Allowances (EUA)(P1) proces below €1 reflecting the oversuplpy inherent in the Phase 1 allocation. A more rigorous allocation prcess has now been applied for Phase 2 with many proposed national allocation plans (NAPs) being cut by the European Commission. So far this has resulted in EUA(P2) forward prices in the second half of 2007 and spot prices in early 2008 in the range €20 – 24 **(A$35 – 41)**.

The Carbon Constrained Economy

Currently, industrialised nation's economies are essentially carbon based, in as much that, carbon based energies such as coal and oil are the major natural resources used in energy production and transportation. However, the production and use of carbon based energy results in ever increasing amounts of carbon dioxide being released into the atmosphere, increasing the greenhouse effect and accelerating global warming.

Countries around the world are now seeking ways to reduce the amount of greenhouse gases released into the atmosphere by human activity in order to ameliorate global warming and the greenhouse effect. The actions being undertaken have resulted in many people concluding that the world is heading toward a carbon constrained economy. A carbon constrained economy is an economy which has to deal with the future effects of global warming (such as increased insurance premiums caused by increased severe weather events), and constraints on the emissions of greenhouse gases.

Many companies, their shareholders and governments now view global warming as a real financial risk. In a carbon constrained economy companies and governments will need to address the risks and opportunities presented by global warming, and changes to energy production and usage. The heavy reliance on carbon based energy will need to change due to shareholder pressure and probable taxes on greenhouse gas emissions. Once the reliance on carbon based energy has changed, the world will enter into the carbon constrained economy.

The Calcination of Carbonates & Energy Usage

In order to further understand the impact that various calcined carbonates have on CO_2 emissions it is important that certain assumptions be made:

1. All of the carbonates will be considered as the same feed size for the sake of these calculations (i.e. nominal 50 mm).
2. The carbonates will be calcined via a twin-shaft regenerative kiln (gas fired) at a top temperature of 1,200 °C.
3. The percentage of decrepitation will have a direct impact on the amount of carbonate available for calcination as well as the efficiency and effectiveness of that calcination.
4. Fine-grained carbonates calcine more effectively than coarse grained carbonates due to heat transfer efficiencies across grain boundaries.
5. Heat transfer is more effective and efficient in carbonates with a higher unconfined compressive strength (UCS).
6. Whilst chemical impurities such as SiO_2 and Fe_2O_3 will certainly affect the quality and performance of the final product they are not always detrimental in the calcining process itself (can transfer heat effectively) and as such will be considered as neutral contributors in the calcining process.
7. The decomposition temperature depends on the partial pressure of the CO_2 present in the process atmosphere and as such will be assumed to be 100% CO_2 at normal atmospheric pressure.
8. That each carbonate material only needs to be burnt once which is achievable with modern kiln technology for each of the stone types listed in Table 2.

Calcination Process

The calcination or burning of limestone, dolomite and magnesite is a simple chemical process. When heated the carbonates thermally decompose according to the following equations:

$CaCO_3$ + approx. 3,180 kJ (760 kcal) = $CaO + CO_2$

$CaMg(CO_3)_2$ + approx. 3,050 kJ (725 kcal) = $CaO.MgO + 2\ CO_2$

$MgCO_3$ + approx. 2,920 kJ (700 kcal) = $MgO + CO_2$

In an atmosphere of 100% CO_2, the initial dissociation temperature for limestone would be 900 °C. Dolomite decomposes in two stages starting at approximately 550 °C for the $MgCO_3$ portion and approximately 810 °C for the calcium carbonate ($CaCO_3$) and a high purity magnesite ($MgCO_3$) will begin to thermally decompose as low as 350 °C.

As stated in the previous synopsis it requires approximately 1.8 tonnes of limestone, comprising 98% $CaCO_3$, to produce one (1) tonne of quicklime (CaO); approximately 2.0 tonnes of dolomite, comprising equal parts of $CaCO_3$ and $MgCO_3$ to make one (1) tonne of dolomitic lime (CaO.MgO) and 2.15 tonnes of magnesite, comprising 98% $MgCO_3$, to produce one (1) tonne of magnesia (MgO).

In order to fully calcine the stone (whether it is limestone, dolomite or magnesite) and to have no residual core, heat supplied to the stone surface must penetrate via conductive heat transfer to the core. A temperature of 900 °C has to be reached in the core at least for a short period of time since the atmosphere inside the material is pure CO_2. The stone surface must be heated to greater than 900 °C to maintain the required temperature gradient and overcome the insulating effect of the calcined material on the stone surface.

As outlined in the assumptions above the carbonates will have a nominal raw feed size of 50 mm and will be heated to 1,200 °C to facilitate complete calcination.

Stone Size [mm]	Calcining temperature [°C]	Approx. residence time [hours]
50	1,200	0.7

Whilst a higher calcining temperature has the potential to generate over-burnt material the major benefit comes from the much smaller residence time which impacts directly on the stones ability to remain intact through the calcining process. Thermal shock (and associated cracking) can also occur at these higher calcining temperatures but most twin shaft regenerative kilns pre-heat the stone thereby overcoming this phenomenon.

In terms of burning efficiencies the propensity of a carbonate to decrepitate (i.e. *break down in a calcining environment due to poor compressive strength, poor grain strength and/or large grain size*) is the primary factor in determining which carbonates will behave more efficiently and thereby generate less CO_2 emissions.

A study undertaken by the author in 1996 entitled, "Investigations into Blast Affected Marble at the Penrice Quarry", revolved around the tendency of "wet" explosives to generate a fabric (structural weakness) in the Penrice Marble such that it would break down readily in the company's vertical shaft kilns. This phenomenon was essentially artificially induced decrepitation. The study showed that up to 6.6% of the marble would report as either hard burnt or un-burnt and as such was useless for on-processing. Whilst the bulk of the decrepitation was essentially blast-induced it did allow the phenomenon to be studied in detail including the role that kiln function and configuration play in the overall performance of the carbonate.

In terms of the Penrice Marble it was observed that the stone usage could increase by as much as 25% when highly decrepitating material was used. This was not just due to the poor performance of the decrepitating marble but also the fact that when it broke down into granular material it interrupted the airflow in the kiln creating cold and hot spots which affected the quality of the end product (i.e. soft and hard burnt material).

It should also be noted that the Penrice kiln feed comprised two size ranges which were mixed together, namely 40 – 80 mm and 80 – 120 mm. This enabled the marble resource to be optimized but did create some operational issues within the kilns. Having taken all of these issues into account along with the fact that the kilns were fired by coke (heat zone is harder to control) it was determined that the highly decrepitating marble was responsible for an apparent drop off in the total carbonate content of around 2.5 – 3.0%.

Thus, in order to formulate good comparative data I have listed a number of criteria against which each carbonate was judged and assigned a "penalty" factor for each characteristic identified as impacting on the final product. Variables such as feed size and kiln type have been assumed a constant as outlined in the assumptions above.

Whilst grain size and the compressive strength of the carbonate are major determinants in the occurrence and degree of decrepitation they are also important in their own right as they influence the rate of heat transfer and the ability of the stone to stay intact on its passage through the heat zone.

The grain size and the compressive strength have been determined to be largely linear relationships and as such have been assigned penalties accordingly.

Decrepitation Potential	**Penalty** (% impact on available carbonate)
Low	0.5 %
Low – medium	1.0 %
Medium	1.5 %
Medium – high	2.0 %
High	2.5 %

Grain Size	**Penalty** (% impact on available carbonate)
Very fine	0.0 %
Fine	0.2 %
Fine – medium	0.4 %
Medium	0.6 %
Coarse	0.8 %

Compressive Strength (UCS)	**Penalty** (% impact on available carbonate)
High	0.0 %
Medium – high	0.2 %
Medium	0.4 %
Low – medium	0.6 %
Low	0.8 %

Table 2 shows a compilation of the various penalties and their impact on the overall availability of carbonate for each material.

The various carbonates in Table 2 have been ranked in terms of their overall kiln performance relative to the best performing material (i.e. greatest conversion of carbonate into the calcined end product) as well as the energy usage required for calcination.

It should be noted that the energy required to convert $MgCO_3$ to MgO is considerably less than that required to convert $CaCO_3$ to CaO (see above) and as such the raw materials with a greater $MgCO_3$ content will require less energy for thermal decomposition.

Table 1 records the energy usage in Terajoules (10^{12} Joules) per thousand tonnes of raw feed.

Electricity usage (consumption) in a standard twin shaft regenerative kiln is typically 23 MWhr per thousand tonnes of end product which can be back calculated to the raw material input on the basis of how many tonnes of each raw material is required to produce one (1) tonne of calcined product. These figures are listed in the previous report and can be weighted against the respective components (i.e. $CaCO_3$ & $MgCO_3$) in each raw material.

For example, it requires approximately 1.8 tonnes of limestone, comprising 98% $CaCO_3$, to produce one (1) tonne of quicklime. Therefore, the electricity usage will be equivalent to 12.8 MWhr per thousand tonnes of limestone.

There are many factors that contribute to the overall performance of any given carbonate within a calcining environment with actual "field" trials offering the best opportunity for gathering absolute values. Nevertheless, the attached tables do give a very sound comparative base from which to work and good approximations of the necessary energy inputs.

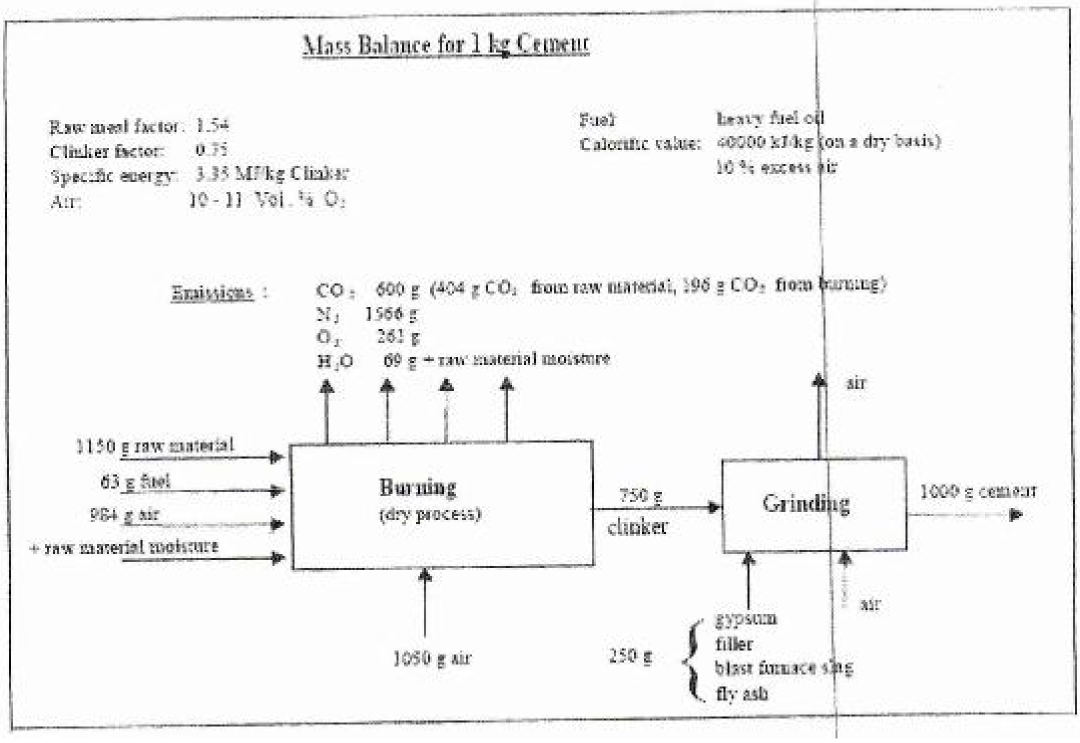

Table 2: A comparison of various carbonates within Australia and the world and their calcining characteristics.

Typical Analysis	Caroline Limestone (SA)	Penrice Marble (SA)	Gambier Limestone (SA)	Heywood Limestone (VIC)	Lilydale Limestone (VIC)	Buchan Limestone (VIC)	Lara Limestone (VIC)	Ardrossan Dolomite (SA)	Redpa Limestone (TAS)
Calcium (Ca)	39.30	38.50	38.00	37.00	32.80	39.00	30.13	21.53	38.59
As Calcium Oxide (CaO)	55.02	53.90	53.20	51.80	45.92	54.60	42.18	30.14	54.02
As Calcium Carbonate ($CaCO_3$)	**98.25**	**96.25**	**95.00**	**92.50**	**82.00**	**97.50**	**75.33**	**53.83**	**96.46**
Magnesium (Mg)	0.44	0.35	1.00	1.00	8.30	0.30	3.60	12.35	0.54
As Magnesium Oxide (MgO)	0.73	0.59	1.67	1.67	10.00	0.50	6.00	20.58	0.90
As Magnesium Carbonate ($MgCO_3$)	**1.51**	**1.23**	**3.50**	**3.50**	**17.50**	**1.05**	**12.60**	**43.22**	**1.89**
Total carbonate content	**99.76**	**97.48**	**98.50**	**96.00**	**96.00**	**98.55**	**87.93**	**97.04**	**98.35**
Decrepitation Penalty	2.00	2.50	2.00	1.50	1.00	0.50	1.50	1.50	0.50
Grain Size Penalty	0.20	0.80	0.40	0.20	0.40	0.40	0.20	0.20	0.20
Hardness (UCS) Penalty	0.60	0.20	0.40	0.40	0.20	0.00	0.40	0.40	0.00
Revised available carbonate	**96.96**	**93.98**	**95.70**	**93.90**	**94.40**	**97.65**	**85.83**	**94.94**	**97.65**
Relative stone usage per '000 tonnes	1,023	1,055	1,036	1,056	1,051	1,016	1,156	1,045	1,016
Energy usage per '000 t (TeraJoules)	3,267	3,294	3,264	3,242	3,195	3,205	3,220	3,132	3,198
Ranking on kiln performance	**8**	**16**	**12**	**17**	**15**	**4**	**18**	**13**	**4**
Ranking on energy usage	**17**	**18**	**16**	**14**	**7**	**10**	**13**	**6**	**8**
Grain Size	Fine	Coarse	Fine - med	Fine	Fine - med	Fine - med	Fine	Fine	Fine
Hardness (compressive strength)	Low - med	Med - high	Medium	Medium	Med - high	High	Medium	Medium	High
Decrepitation potential	Med - high	High	Med - high	Medium	Low - med	Low	Medium	Medium	Low

Typical Analysis	Fujian Limestone (CHINA)	Vietnamese Limestone (VIETNAM)	Indian Dolomite (INDIA)	Egyptian Limestone (EGYPT)	Iranian Limestone (IRAN)	Dalian Magnesite (CHINA)	Arthur Magnesite (TAS)	Redpa Dolomite (TAS)	Togari Dolomite (TAS)
Calcium (Ca)	38.80	39.20	21.43	39.46	38.80	2.86	3.57	21.53	23.47
As Calcium Oxide (CaO)	54.32	54.88	30.00	55.24	54.32	4.00	5.00	30.14	32.86
As Calcium Carbonate ($CaCO_3$)	**97.00**	**98.00**	**53.57**	**98.64**	**97.00**	**7.14**	**8.93**	**53.82**	**58.68**
Magnesium (Mg)	0.10	0.03	12.00	0.07	0.30	25.80	25.92	12.84	11.77
As Magnesium Oxide (MgO)	0.17	0.05	20.00	0.12	0.50	43.00	43.20	21.40	19.62
As Magnesium Carbonate ($MgCO_3$)	**0.35**	**0.11**	**42.00**	**0.25**	**1.05**	**90.30**	**90.72**	**44.94**	**41.20**
Total carbonate content	**97.35**	**98.11**	**95.57**	**98.91**	**98.05**	**97.44**	**99.65**	**98.76**	**99.88**
Decrepitation Penalty	0.50	0.50	0.50	1.50	0.50	1.00	0.50	0.50	0.50
Grain Size Penalty	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.20
Hardness (UCS) Penalty	0.20	0.20	0.20	0.60	0.00	0.40	0.00	0.00	0.00
Revised available carbonate	**96.45**	**97.21**	**94.67**	**96.61**	**97.35**	**95.84**	**98.95**	**98.26**	**99.18**
Relative stone usage per '000 tonnes	1,028	1,020	1,048	1,027	1,019	1,035	1,002	1,009	1,000
Energy usage per '000 t (TeraJoules)	3,209	3,209	3,101	3,255	3,198	2,988	2,963	3,077	3,093
Ranking on kiln performance	**10**	**7**	**14**	**9**	**6**	**11**	**2**	**3**	**1**
Ranking on energy usage	**11**	**11**	**5**	**15**	**8**	**2**	**1**	**3**	**4**
Grain Size	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Very fine	Fine
Hardness (compressive strength)	Med - high	Med - high	Med - high	Low - med	High	Medium	High	High	High
Decrepitation potential	Low	Low	Low	Medium	Low	Low - med	Low	Low	Low